

Unreasonable Expectations

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A couple of days ago a story went up on a Portland, OR news station's website trumpeting the imminent arrival of an [earthquake warning system for the Pacific Northwest](#). Among other things, the story quoted John Vidale of the University of Washington saying that the proposed ShakeAlert system could provide up to several *minutes* of warning before you feel the shaking. This [isn't the first time](#) he has [made that claim](#), and [he's not the only one](#) to make it. The same claim has been made for the proposed ShakeAlert system in California, where the typical number is "over a minute of warning" for San Francisco or Los Angeles.

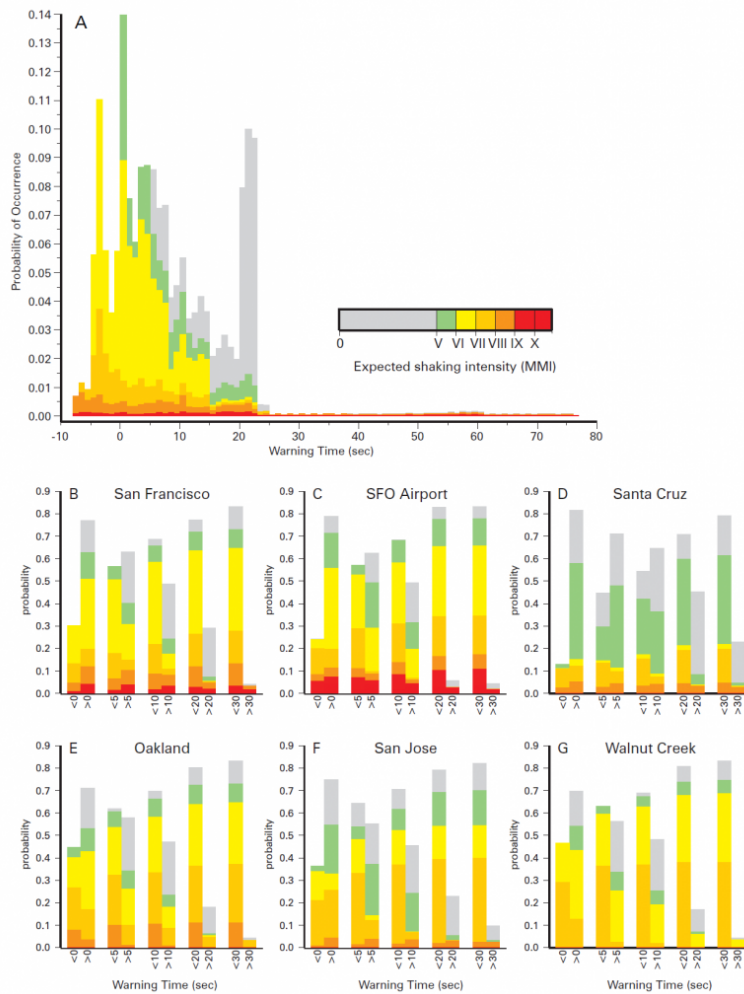
So, first of all, I want to be clear: yes, such generous warning times are theoretically possible. Typical quoted numbers are a little over a minute in San Francisco, a minute and a half in LA, three minutes in Portland, five minutes in Seattle. They are possible if:

1. The city in question is close to a very large fault, and
2. The epicenter of the earthquake happens to be very far from the city, but
3. The earthquake is large enough (think magnitude 8+) that the city experiences significant shaking, despite the distance to the epicenter (remember way back to my very first post on this blog: [The First D](#)), and
4. The recipients of the warning don't mind getting low-ball or speculative ground motion estimates, since the true size of such a massive event won't be known for at least a minute or two.

Notice that the list above doesn't include any question of the technical feasibility of ShakeAlert itself. I'll concede that the system can be built to the specification that is being publicized. Even though there is no false advertising here, it is irresponsible to promote any earthquake warning system as providing "minutes of warning" for several reasons. First of all, "minutes" sounds like a long time, and that time has a tendency to grow in the retelling, especially if a specific number is not given. I've personally heard public officials claim that the warning system being developed will provide 15 minutes of warning! The scientists who keep making the "minutes" claim may be disciplined in sticking strictly to what is technically possible, but members of the public do not have that discipline. What's more, when you talk about "seconds" of warning that makes it easier to connect in people's minds that this is *not* an earthquake prediction system. That is, the warning does not come *before* the earthquake. That fact is much harder to convey when the timescale is "minutes" because most people think of earthquakes as more or less instantaneous.

The real reason this is dangerous though, is that it gives the public a completely unreasonable expectation of the performance of *any* earthquake warning system. It's one thing to say "give me \$120 million and I'll give you five minutes of warning," but quite another to say "give me \$120 million and I'll give you 15 seconds." It's much much harder to get public buy-in with the latter claim, but the fact is that yes, a moderate event right beneath our feet (say a M 6.5 to 7 on the Hayward or Newport-Inglewood Faults) is far more likely to occur than a great M 8+ event. And even if we do see a M 8+ on the San Andreas or Cascadia Faults, the likelihood of the epicenter

by chance being as far from the major cities as possible is extremely small.



Just how much more probable is a warning time of a few seconds than one of a few minutes? I'd have to do a probabilistic study of all the available scenario earthquakes for California and calculate warning times to tell you. Fortunately, I don't have to do that because it happens that Richard Allen, a big advocate of the ShakeAlert system (and full disclosure, also my former Ph.D. adviser) published [just such a paper](#) in 2006. The main figure from that paper is reproduced here. The data is nearly 10 years old now, and both the networks and the earthquake science have advanced since then, but the conclusion is largely unchanged: for earthquakes that cause moderate or greater shaking in San Francisco (all the colors in the figure except for gray), the probability of warning times greater than 15 seconds is small, and the probability of getting more than 20 seconds is tiny. A careful reading of graph B in

the figure shows about a 7% chance in 30 years of experiencing MMI 5 (V) or stronger shaking in San Francisco with more than 20 seconds of warning, but about a 72% chance of experiencing that shaking with less than 20 seconds of warning. So it's more than ten times as likely that the average San Francisco resident, who willingly paid into the \$120 million bill for ShakeAlert, will experience a warning time that is significantly less than they were expecting.

I have asked the academic community in the past to tone down the wild claims and do a better job of managing expectations. This is in part self-interest, because we have a hard time making more realistic claims of several seconds' warning, when the people we talk to are used to hearing about several minutes' warning. But beyond that it's really important to be honest with the public, who are after all being asked to foot the bill for this system.